

Title of the Invention: Hinge Mechanism for a Limb Protector

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Related Application

1. The priority claim is of Patent Number PCT/GB98/00713, filing date
2.
3. 03/05/98, Priority date 03/05/97
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5. ~~Related Applications:~~
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8. This invention relates to a hinge mechanism for a limb protector for the
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10. joint of a human limb, that is a knee or elbow protector. Therefore it
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12. can have related application as a knee or elbow brace.
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15. Background to the Invention:
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18. Injuries to the limbs and their joints occur for several reasons,
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20. including participation in contact sports such as American football
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22. ice hockey, in individual sports such as skiing or motorcycle
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24. racing or indeed any active sport. In addition injuries to limbs and
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26. their joints occur in active occupations such as armed forces, or in
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28. any type of accident.
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30.

31. After an injury occurs, it is often desirable to either slightly restrict the
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33. movement of the limb or the joint, for example by elastic support, or
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35. severely restrict movement of the limb or joint by ridged splints, or

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36
37 ridged braces that restrict the degree of movement of the limb or
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39 joint, for example by hinged knee or elbow braces, (de-rotational
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41 braces).

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43 Such braces which are available to prevent twisting of a knee or
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45 elbow can be worn during activities such as skiing and can have
46
47 preventative as well as protective effect. Such hinged braces are by
48
49 their very nature restrictive of movement and permit only forward
50
51 bending of the knee or elbow. Other braces are available for sports
52
53 such as American football which protects the knee against side
54
55 impact or frontal impact but also restrict movement (prophylactic or
56
57 preventative braces). Dynamic braces are also available with
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59 eccentrically placed hinges to provide protection to torn ligaments.

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61 The present invention relates to rigid hinged braces.

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63 Related art:

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66 WO 94/18916 discloses a variety of hinged braces to be worn for the
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68 protection or support of a damaged or potentially damageable joint.

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70 The braces disclosed have, when applied to a knee joint,
71
72 respective upper and lower rigid supports which engage the leg above
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74 and below the knee and which are hinged one to the other to allow
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76 bending of the joint.
77
78 Because of the way the joint of the human knee is physically
79
80 constructed the bending of a joint can occur around any point within a
81
82 given area covering that joint when that joint is viewed from the
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84 side, or in a direction substantially parallel to the axis of rotation of
85
86 the exact point about which the joint rotates is dependent upon the
88
89 the limb either side of the joint, or the amount by which the limb, and
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91 hence the joint has already been bent. When for example the
92
93 joint being rotated is the knee, the points about which rotation may
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95 occur may be either side of the cartilage that separates the tibia and
96
97 fibula bones on the one side, and the femur on the other side of the
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99 knee joint or on both sides of the cartilage. Accordingly, to hinge the
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101 upper and lower supports together about a simple pivot is
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103 unsatisfactory. Instead, in preferred constructions as shown in
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105 Figures 5 and 16 of WO 94/18916, each is pivoted to an intermediate
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107 member and the two intermediate members are pivoted to one
108
109 another. This allows the axis of rotation to vary relative to the
110
111 joints, e.g. When moving from
112
113 standing vertically to bending one's knees.
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115 The assembly shown in W094/18916 are cumbersome and complex
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117 to assemble, and require the manufacture of a plurality of telescopic
118
119 shells which must slide over one another easily, but which must be
120
121 sufficiently rigid and impact resistant (as such braces are often worn
122
123 during contact sport play to enable play to occur but reducing
124
125 the risk of further injury to a recovering limb) to ensure that such
126
127 movement can be maintained without jamming. These criteria are
128
129 not easy to meet.

130
131 I have now found that a much more effective and robust hinging
132
133 mechanism can be provided which maintains the flexibility of
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135 movement provided by the constructions shown in WO 94/18916,
136
137 but which does not incur its disadvantages. In particular, it may
138
139 enable easy assembly and disassembly and is very resistant to
140
141 mechanical damage.

142
143
144 British Government Sponsored Research Grant

145
146 The development of this invention was funded by the United
147
148 Kingdom Grant: Supports for Products Under Research grant, this
149
150 grant was known as the SPUR grant.

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155 **Brief Summary of the Invention:**
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157 According to the present invention there is provided a hinge
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159 mechanism for a limb protector including first and second supports
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161 each adapted to engage a part of a limb in either side of an
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163 articulated joint, the hinge mechanism being pivotally connected to
164
165 both supports, and wherein the hinge mechanism comprises a base
166
167 plate, an arm pivotally rotatable against the plate about an axis
168
169 substantially perpendicular thereto and located to one end of the arm
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171 and means (by way of connecting screws) for connecting the support
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173 members pivotally to the other end of the arm and to the plate, all of
174
175 these three axes of rotation of the pivotal connections being
176
177 substantially parallel, and wherein associated with each of the three
178
179 pivotal connections are means for restricting the relative degree of
180
181 rotation of the respective two members to a defined amount.
182
183 Preferably, the arm is mounted rotationally on a circular boss on the
184
185 plate and the plate has stop means formed thereon restricting the
186
187 angular rotation of the arm, e.g., to a maximum of 60 degrees.
188
189 Preferably, the angular rotation of each support member relative to
190
191 the end of the arm or the base plate respectively is restricted by the
192
193 passage of a stud or post along an arcuate slot centred on the pivot
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195 axis.

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197 The post is conveniently on the base or arm and the arcuate slot in

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199 the support member. The extent of the arcuate slot may vary, but is

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201 commonly in the range of 50 degrees to 110 degrees.

202

203 By hinging of the supports together using a hinge mechanism

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205 according to the present invention, with all three pivots having a

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207 restricted degree of rotation, the degree of rotation of each of the first,

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209 second and third pivotal connections may be set to predetermine the

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211 maximum translational and rotational movement between the bones

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213 of the joint around which the brace is to be fixed. This may be

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215 achieved by providing slots of lengths corresponding to the maximum

216

217 likely desired degree of pivotal movement, e.g. 60 and 90

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219 degrees and then limiting the degree of rotation of either or both

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221 slots by inserting into the arcuate slot spacers or other means of

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223 preventing rotation, so that the relevant studs or posts may move

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225 only along a portion of that slot.

226

227 The degree of rotation available to the arm may be limited by locating

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229 the arm in a recessed portion of the plate which is bounded by radial

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231 walls e.g. inclined at 60 degree to one another. To limit the degree of

232

233 rotation further spacers or other means of preventing rotation may be

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235 fixed within the recess. In place of a recess with walls, the amount of
236
237 rotation of the arm may be defined by studs mounted on the plate.
238
239 The hinge mechanism of the present invention may be made of any
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241 suitable material, preferably aluminium alloy, though, if desired,
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243 suitable engineering plastics materials may be used. The support
244
245 members are conventionally made of ^{rigid} ~~ridged~~ material. In order to
246
247 avoid over stressing such materials where they are connected to the
248
249 hinge mechanism, reinforcements, e.g. of metal, may be installed. In
250
251 particular, it is found useful to reinforce the edges of the arcuate slots
252
253 with a metal plate or liner.
254
255 In use, each limb protector or brace would have a hinge mechanism
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257 according to the present invention on either side of the joint around
258
259 which the brace was placed.
260
261 The hinge of the present invention may be employed on all currently
262
263 known types of kneebrace once suitable modification has been made
264
265 to those knee braces. In particular, the present invention is of value
266
267 applied to braces as described in WO 94/18916, with the arrangement
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269 as described above replacing the front plates of the hinged brace
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271 described therein.
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275 BRIEF DESCRIPTION OF DRAWING

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278 The invention is illustrated by way of example with reference to the
279 accompanying drawings in which:
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282 Figure 1 shows a perspective view of the knee brace incorporating a
283 hinge mechanism according to the present invention, and
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286 Figure 2 shows a detail of the brace of Figure 1 in exploded view.
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290 DETAILED DESCRIPTION OF INVENTION

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292 Referring to Figure 1, the knee brace which is illustrated lying on its
293 side and from the back as shown in the drawings, consist basically of
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295

296 upper and lower hollow shell (or supports members 1 and 2 are
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298

299 respectively shaped to accommodate the thigh and calf of the
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301

302 wearer. Members 1 and 2 are joined by hinge mechanism 3 and
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304

305 4, described in more detail below, and may be held on the
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307

308 respective parts of the legs by means of hard
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310

311 moulded semi- cylindrical portions 5 and 6. Projecting from the ends
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313

314 of portions 5 and 6 are locating tabs and straps which fit into
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316

317 corresponding apertures in members 1 and 2 via appropriate snap
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319

320 action catches enabling each to be pushed towards the member 1
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322

323 and 2 respectively to fit snugly around the thigh or calf respectively.
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325

315 Substantially the whole of the interior of members 1 and 2, 5 and 6 is
316
317 lined with a cushioning foam for comfort. Fitted to the interior of
318
319 each of the members 1 and 2 are some short metal rods which are
320
321 substantially vertical when the brace is worn with the wearer standing
322
323 upright. These are obscured in the drawing by double-sided burr
324
325 fastener straps 10, 11, 12 and 13. Straps 12 and 13 are relatively short
326
327 and one end of each terminates in an elongate plastics ring 15 and 16
328
329 respectively through which the free end of the rather longer straps 10
330
331 and 11 may be passed and then folded back on itself to tension each
332
333 strap round the rear of the lower thigh and upper calf respectively.
334
335 The central portions of the longer strap 10 and 11 may be fabrics
336
337 faced than faced with burr fastener material, for greater comfort.
338
339 Hollow shell member 2 is constructed in two parts, the left hand one
340
341 of which as shown in the drawing has an annular outward facing
342
343 groove 20 and the other portion of which to the right in Figure 1
344
345 has an annular inward facing rib 21. Rib 21 can slide in the annular
346
347 grove to a certain extent, thus allowing a limited degree of
348
349 swivelling between the portion of the brace which is attached to
350
351 the thigh and the portion which is attached to the calf. This
352
353 swivel feature is described in more detail in Specification
354

355 WO94/18916. The right hand portion of member 2 is held
356
357 captive in the left hand portion by means of a pair of squat T-section
358
359 bosses which pass through two short slots 25 and 26 located in the
360
361 base of groove 20.
362
363 In accordance with the invention, members 1 and 2 are held together
364
365 by two hinged mechanisms 3 and 4. Each of hinge mechanism 3
366
367 and 4 consists of a base plate 40, 41 respectively which is
368
369 pivotally attached directly to member 1 and which has mounted
370
371 on it a swivellable arm to the free end of which is pivotally
372
373 attached member 2.
374
375
376 The detailed construction of the hinge mechanism 4 is shown in
377
378 Figure 2. The construction of hinge mechanism 3 is identical
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380 save for being a mirror image of hinge mechanism 4. Referring
381
382 now to Figure 2, this shows an exploded view of the hinge
383
384 mechanism with the two members 1 and 2 detached from the
385
386 base plate 41 and the arm contained therein, for clarity of
387
388 explanation.
389
390 Base plate 41 has two threaded bosses on its surface facing hinge
391
392 mechanism 3. One of these, denoted 50 in Figure 2, acts as the
393
394 pivotal connection between base plate 41 and member 1 and

395
396 pivots about an axis substantially ^{perpendicular} ~~perpendicular~~ to the base plate 41.
397
398 For this purpose, a lockable threaded stud 51 may be passed
399
400 through an aperture 52 in member 1 and screwed into boss 50 which
401
402 is internally threaded.
403
404 As that occurs, an upstanding arcuate tab 54 enters in to an arcuate
405
406 slot 55 in the material of member 1, slot 55 being centred on
407
408 aperture 52. Not shown in the drawing is a metal reinforcement
409
410 which is moulded into the exterior of member 1 and which has
411
412 an aperture registered with aperture 52 and arcuate slot registered
413
414 with arcuate slot 55. When member 1 is accordingly assembled on to
415
416 base plate 41, it can pivot relative thereto, but only to the extent
417
418 allowed by the travel of tab 54 in slot 55.
419
420 If it is desired to restrict the range of rotation of member 1 relative to
421
422 base plate 41, a suitable stop member may be inserted at one or both
423
424 ends of slot 55.
425
426 Mounted on base plate 41 is a swivel arm 60. The left hand end of
427
428 this arm as seen in Figure 2 is of ring shape and fitted round a further
429
430 threaded post formed integrally with base plate 41 and held in place
431
432 by a screw-in stud 61. The circular left hand end of arm 60 is
433
434 located in a generally circular recess 62 in base the plate 41.

435
436 This recess is a continuation of the internal wall 68 and is formed
437
438 from two radial sections, one 80 having a radius only slightly greater
439
440 than the radius of the ring on the left hand arm of arm 60 and the
441
442 other 90 having an enlarged radius forming the two part cylindrical
443
444 wall of recess 62 abutting at a shoulder 64 which lies in a radial plane
445
446 relative to the hidden threaded stud about which arm 60 may swivel.
447
448 On one side of the generally ring-shaped end of arm 60 is a partial
449
450 annular flange 66 which, when its end as shown on the left in
451
452 Figure 2 abuts shoulders 64, limits the clockwise rotation of arm
453
454 60. The anti-clockwise rotation is limited by the right hand end of
455
456 arm 60 as shown in Figure 2 coming to abut an internal wall 68
457
458 formed in base member 41. Thus, arm 60 may swivel through a
459
460 defined angle, which may be reduced by inserting packing
461
462 members against shoulder 64 or wall 68 if it is desired to do so. It
463
464 can be also be seen that the radial sections 80, 90 which are part of
465
466 wall 68 are lined at an angle to one another.
467
468 Member 2 is pivotally connected to the right hand end of arm 60
469
470 about an axis substantially perpendicular to the base plate by
471
472 means of a threaded stud 70 which passes through an aperture 71 in
473
474 member 2 and into a threaded post 72 on the end of arm 60. Arm 60

475
476 is formed with an upstanding tab 74 or post which, when member 2 is
477
478 assembled on to the arm 60, passes through an arcuate slot 76 in
479
480 member 2.
481
482 Again, the extent of rotation permitted between arm 60 and member 2
483
484 may be reduced by inserting stop members into one or both ends of
485
486 arcuate slot 76.
487
488 The outer periphery of base plate 41 may be contoured so that its
489
490 inner face lies closely against the exterior faces of members 1
491
492 and 2 thus reducing the ingress of dirt or other contamination when
493
494 the knee brace is worn. The hinge mechanism 3 and 4 permit natural
495
496 flexure of the wearer's leg with the three pivotal connections, the
497
498 pivot axes of which correspond to the threaded shafts of studs 51,
499
500 61 and 70, enabling a natural and comfortable movement to
501
502 occur. Excessive flexure of the joint, beyond what the wearer's
503
504 medical or physiotherapist advisors would recommend, may be
505
506 prevented by restricting the range of angular movement of one,
507
508 two or all three of these pivotal connections by the use of
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510 packing members as indicated above. The support members are
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512 made from rigid plastic or fibre reinforced resin type composition.

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